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Evaluation of the Interactive Electronic Technical Manual/Automated Classroom (IETM/AC)

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The Navy Personnel Research and Development Center (NPRDC), working with the Naval Sea Systems Command (NAVSEA) and Chief of Naval Education and Training (CNET), completed a program of research, development, and evaluation for automating classroom activities in which interactive electronic technical manuals (IETMs) are used. The project addressed two Navy training problems: (1) the need to utilitze emerging technologies to improve maintenance performance and reduce maintenance costs and (2) the need to improve the efficiency of the Navy training pipeline. These problems are being addressed by combining IETM technology with an integrated multimedia editing and delivery system.

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Foreword

The Interactive Electronic Technical Manual/Automated Classroom (IETM/AC) project was sponsored by Bureau of Naval Personnel under Program Element 0603707N. A research, development, and evaluation program was completed for automating classroom activities with IETMs. This report is directed to training communities and program managers who may be developing or implementing IETMs and automated classrooms.

J. C. McLACHLAN
Director, Classroom and Afloat Training

Summary

Background

The Navy Personnel Research and Development Center (NPRDC), working with the Naval Sea Systems Command (NAVSEA-04PT) and Chief of Naval Education and Training (CNET-05), completed a program of research, development, and evaluation for automating classroom activities in which interactive electronic technical manuals (IETMs) are used. The project addressed two Navy training problems: (1) the need to utilize emerging technologies to improve maintenance performance and reduce maintenance costs and (2) the need to improve the efficiency of the Navy training pipeline. These problems are being addressed by combining IETM technology with an integrated electronic multimedia editing and delivery system. The system takes advantage of advances in technology that uses electronic data, permits new ways of creating and delivering classroom instruction, and provides standardized ways of interchanging various forms of electronic text and graphics.

Objective

The objective of this evaluation was to determine the suitability of the IETM/AC system for developing, revising, and delivering Navy instruction in the classroom.

Approach

Two evaluation areas are described. They are (1) the technical aspects of the IETM/AC system and (2) the user experiences with the IETM/AC system reported during the evaluation period. Software system development, specifications, and documentation of the technical system criteria emerged from the development of the system. System capabilities and characteristics were evaluated by conducting a technical overview of the system, observing use of the system, and collecting user reports during pilot tests. Questionnaires, interviews, and observation notes were used to record this information. System hardware and software requirements were documented. Methods for expanding the IETM/AC computer architecture to accommodate MS-Windows applications and IGs authored in a range of word processing programs were evaluated.

Information pertaining to user experiences during pilot usage of the IETM/AC system was collected. Pilot usage refers to instructor, student, and institutional experiences with the prototype system. These reported user experiences pertain to acceptance and satisfaction, ease-of-use, system performance, and descriptions of institutional characteristics, effects, and site activities. Survey instruments were developed to gather information from instructors and students on their use of the system. Institutional impacts were identified. Those impacts included instructional development and delivery, institutional efficiency, overall acceptance, and the affect on personnel. Performance scores were obtained for a comparison of those who attended paper-based versus automated courses.

Conclusions

Overall the personnel interviewed had positive comments about the automated classroom system. Major concerns were the need for more experienced computer support personnel, the

perceived lack of quality graphics in the Gas Turbine IETM, and a concern over the reduction in the length of the training courses.

The IETM/AC has tremendous potential to become tomorrow's tradition by providing a new innovative learning environment. Instructors and students learned to use the IETM/AC system in a short amount of time.

A comparison of student performance scores in the traditional paper-based classes and the IETM-based classes showed promising results. There was slight improvement in overall average student scores for IETM-based versus paper-based courses.

The IETM/AC expanded system architecture, using Training Integration Management Software (TIMS), accepts course materials from a variety of sources including AIM, SGML editors, instructional authoring programs, and PC word processors. Augmenting TIMS will provide several benefits beyond the classroom. Cost savings should be achieved by eliminating the requirement to convert legacy data and course materials prepared with word processing or other authoring programs to SGML format.

Recommendations

Choose the appropriate course for automation. The course targeted for automation should undergo a thorough Instructional Systems Design analysis before the training materials are developed.

Conduct a site survey to include required facilities modifications, course and personnel requirements, and visit an established automated classroom to learn from other's experiences.

Keep IGs and TGs separate from the IETM. Course materials should not be embedded in the IETM. This will save money and time when either the course or the IETM requires revision; there will be no need to return to the IETM source for curriculum revisions.

Billets should be established for systems administration and life cycle maintenance of hardware, software, and courses. Existing instructors and support personnel cannot provide the necessary support without additional training and billets.

Learning Resource Centers should be integrated with the classrooms, be staffed by instructors and be available for after hours study. This will free up classroom space for other courses and provide needed student access for after hours studying.

Multiple classrooms should be networked with a central file server. This will allow sharing of data, easy reconfiguration of classrooms with different courses, and make course maintenance more efficient. Life cycle maintenance and configuration management are more difficult if classrooms are not networked.

Instructor workstations should be available in the instructor preparation areas. This will allow them to personalize their materials and prepare for lectures without tying up the classroom.

Contents

	Page
Introduction	1
Background	1
Objective	2
Approach	2
Technical Aspects of the System	2
User Experiences	2
IETM/AC System	3
Instructor Station Hardware Configuration	3
Student Station Hardware Configuration	4
Automated Classroom Components	4
Subjects	5
Data Collection Methods and Instruments	5
Survey	6
Test Scores	6
Training Integration Management Software (TIMS)	6
Student Performance	8
Instructor Survey	10
Structured Interviews	11
Instructors	11
Supervisory Personnel	12
Support Personnel	12

Student Survey 12

Institutional Impacts 14

Conclusions 14

Recommendations 16

References 17

List of Figures

1. Automated classroom configuration 5
2. TIMS screen layout 7
3. Test scores for GSE classes 9
4. Test scores for GSM classes 9
5. Instructor survey results 11
6. Student survey results 13

Introduction

Background

The Navy Personnel Research and Development Center (NPRDC), working with the Naval Sea Systems Command (NAVSEA-04PT) and Chief of Naval Education and Training (CNET-05), completed a program of research, development, and evaluation for automating classroom activities in which interactive electronic technical manuals (IETMs) are used. The project addressed two Navy training problems: (1) the need to utilize emerging technologies to improve maintenance performance and reduce maintenance costs and (2) the need to improve the efficiency of the Navy training pipeline. These problems are being addressed by combining IETM technology with an integrated electronic multimedia editing and delivery system. The system takes advantage of advances in technology that uses electronic data, permits new ways of creating and delivering classroom instruction, and provides standardized ways of interchanging various forms of electronic text and graphics.

In 1993, NAVSEA tasked Martin Marietta to design a system to deploy IETMs in Navy classrooms. Their objective was to produce an integrated database which would be used aboard ship for improved maintenance performance and in the schoolhouse to provide a dynamic interactive training environment, thus improving shipboard performance, enhancing training, and reducing course length. The Gas Turbine Technician Journeyman Training or "C" school at Great Lakes Training Center, IL was chosen as the test bed.

NAVSEA focused on the technical applications of IETMs in the classroom and defined the scope of the IETM database, developing the maintenance diagnostic and operations viewpackages, and electronically enhanced Instructor Guides (IGs) and Trainee Guides (TGs).

NPRDC evaluated the impact of the automated classroom on student performance, course content and length, as well as time and cost issues. NPRDC and NAVSEA developed implementation recommendations and system specifications. The IETM/AC architecture was expanded to accept curriculum materials developed with a variety of word processing and curriculum authoring programs.

Products resulting from this effort include (1) an instructional delivery architecture using format neutral components, known as the Training Integration Management Software (TIMS), (2) an evaluation that documents the effects of an automated instructional system, (3) enhancement of the automated GS Electrical (course identification number A-652-0328) and GS Mechanical Maintenance (course identification number A-652-0303) courses, (4) a cost/benefits analysis report, (5) a survey of IETMs used for training and education report, and (6) implementation recommendations and system specifications.

The Advanced Development sponsor for this effort was LCDR Tim Steele (PERS-OOH11). The Implementation sponsor was Ms. Saundra Drummer (CNET N5214).

Objective

The objective of this evaluation was to determine the suitability of the IETM/AC system for developing, revising, and delivering Navy instruction in the classroom.

Approach

Two evaluation areas are described. They are (1) the technical aspects of the IETM/AC system and (2) the user experiences with the IETM/AC system reported during the evaluation period.

Technical Aspects of the System

Software system development, specifications, and documentation of the technical system criteria emerged from the development of the system. This documentation describes the system and subsystem components and software capabilities. System capabilities and characteristics were evaluated by conducting a technical overview of the system, observing use of the system, and collecting user reports during pilot tests. Questionnaires, interviews, and observation notes were used to record this information. System hardware and software requirements were documented. Methods for expanding the IETM/AC computer architecture to accommodate MS-Windows applications and IGs authored in a range of word processing programs were evaluated.

User Experiences

Pilot usage refers to instructor, student, and institutional experiences with the prototype system. These pertain to acceptance and satisfaction, ease-of-use, system performance, and descriptions of institutional characteristics, effects, and site activities. Survey instruments were developed to obtain information from instructors and students on their use of the system.

Instructors were asked to estimate the time and effort to translate information into the electronic system, to update instructional materials when revisions were necessary, to prepare for their lectures using the system, and to be trained on the system. Instructors also were asked to evaluate the use of this system for delivering instructional materials, overall classroom environment, and to provide suggestions for improving the system.

Students were asked to evaluate the system for ease-of-use and the utility of the student workstation. Instructor comments on performance while using the system, overall classroom environment, impact on student learning, and suggestions for system improvement were obtained. Performance scores were obtained for students attending paper-based and automated courses.

Institutional impacts were identified. Those impacts included instructional development and delivery, institutional efficiency, overall acceptance, and the affect on personnel. Costs and impacts associated with implementation of the IETM/AC system were identified and discussed in a cost benefits analysis report (Mark, Kribs, Morris, & Dickason, 1996).

IETM/AC System

The classroom is designed to use Commercial Off The Shelf (COTS) hardware and software. The Gas Turbine IETM utilizes the Info Access GUIDE™ product for computer display of the technical information. Over 110,000 pages of technical information were converted to electronic format and Standard Generalized Markup Language (SGML) tagged during the development of the GS IETM. Converted data were uploaded into an object oriented database using relational database management software. The GSE and GSM course materials were embedded in the IETM. To create IETM functionality, viewpackages for general knowledge, troubleshooting, maintenance, and operations were developed. Linking the IETM to the IG and other applications was required for computer presentation of the electronic "book" with hypertext/hyperlink capability. This IETM development process was examined and a survey of IETMs used in education and training, both in other services and in the civilian community, was conducted (Kribs, Mark, Morris, & Dickason, 1996).

The Mine Countermeasures (MCM) Isotta Frachini IETM, piloted with the Training Integration Management Software (TIMS), is displayed by the Electronic Book DynaText™ product. The MCM course materials were authored in Word Perfect and not SGML tagged. Other automated classrooms may require different hardware and software, depending on the course, the IETM, and facility requirements. Figure 1 provides a graphic of the present automated classroom configuration.

Instructor Station Hardware Configuration

This instructor station configuration included the following COTS software: MS DOS 6.22, Windows for Work Groups 3.11, MS ACCESS, Guide Reader, Video for Windows, and SYTOS tape back-up package.

- 486 DX/4 100 MHz CPU
- 16 megabyte RAM
- 3.5" 1.44 megabyte floppy drive
- 6 gigabyte hard drive
- 3 X CD-ROM drive
- 32 bit Sound Blaster card
- 32 bit LAN card
- Tape Drive
- 20" SVGA monitor
- Keyboard
- Mouse
- Laser Printer
- VCR

Student Station Hardware Configuration

The student station configuration, at the time of the study, included the following COTS software: MS DOS 6.22, Windows for Work Groups 3.11, MS ACCESS , Guide Reader, and Video for Windows.

- 486 DX/4 100 MHz CPU
- 16 megabyte RAM
- 3.5" 1.44 megabyte floppy drive
- 2.572 gigabyte hard drive
- 3 X CD-ROM drive
- 32 bit Sound Blaster card
- 32 bit LAN card
- 17" SVGA monitor
- Keyboard
- Mouse

Automated Classroom Components

- EtherNet LAN to connect instructor station (server) to student stations (clients)
- Xerox LiveBoard, 67" projection monitor with VGA resolution of 640x480, with an Intel 486 DX/2 66 MHz CPU
- LINK Video Networking System to allow instructor to view student monitor displays on his screen, switch and display to Xerox LiveBoard or display on all monitors.

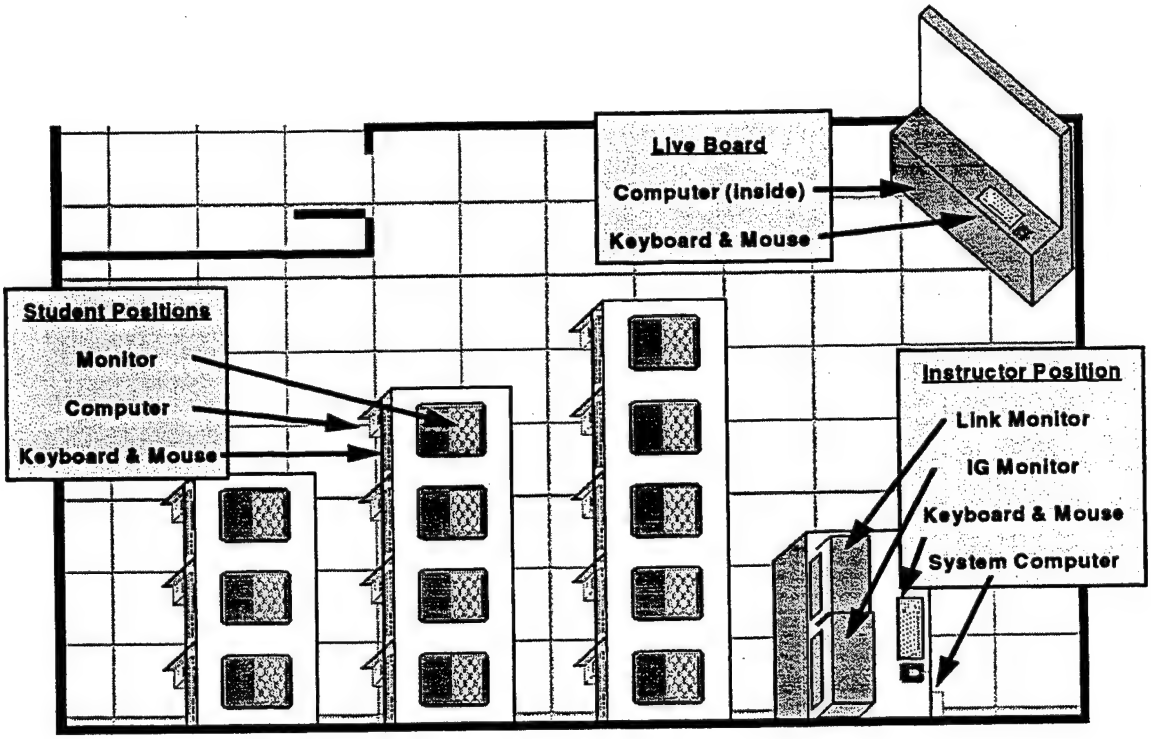

Figure 1. Automated classroom configuration

Subjects

Forty-eight enlisted military students, attending the IETM gas turbine "C" school courses participated in the study. The majority of these students were rated E-5 and below. In general they had returned from the fleet, rather than directly from a prior school, to attend these "C" school courses.

Nine enlisted military instructors participated in the study. These Instructors were rated E-6 and E-7.

Data Collection Methods and Instruments

Information was obtained by observing the classroom in use, conducting structured interviews with instructors, students, and support personnel, surveying instructors and students, and reviewing test scores from previous (paper-based) as well as the present automated classes. Test scores for the Gas Turbine courses, GSE (A-652-328) and GSM (A-652-303), were obtained from the Instructional Support System (ISS) database.

Survey

A survey was designed to gather experiences using the system, both from students and instructors. Survey statements were rated on a five-point scale, "Strongly Agree to Strongly Disagree," and were followed by open-ended questions. The survey was administered to students and instructors during instruction.

Test scores

Test scores were obtained for written tests and final course average. The final course average consisted of a final exam (40%), laboratory exercises (40%), homework (10%), and quizzes (10%). The tests were paper-based.

Training Integration Management Software (TIMS)

The IETM/AC computer architecture was expanded to use MS-Windows standards and will accommodate lesson plans and Instructor Guides (IGs) from a variety of sources including the Authoring Instructional Materials (AIM) system, SGML editors, and PC word processors. This expanded architecture, which can use a range of inputs, is referred to as "format neutral." Training Integration Management Software (TIMS), a software module that manages a database of annotations for IGs and TGs, supports format-neutral processing. TIMS was piloted from July through September 1995 and is still being used for the MCM course. This course provided a testbed for the development of a TIMS Word Perfect browser which is described below.

Figure 2 below shows the Main Screen (following a login procedure) of the TIMS package. The Main Screen is where all tasks are performed using TIMS. It actually consists of four separate panes. The Control pane is the narrow vertical window along the left side of the display in Figure 2. This pane contains buttons which control the other three panes. The Instructor Guide (IG) pane always occupies the top part of the display. This is where the IG is displayed. The Notes pane is located below the left side of the IG pane. This pane contains any personal annotations that has been added by the instructor. The Related Instructor Activity (RIA) pane lies to the right of the Notes pane. This pane contains any annotations that have been added by the curriculum developer.

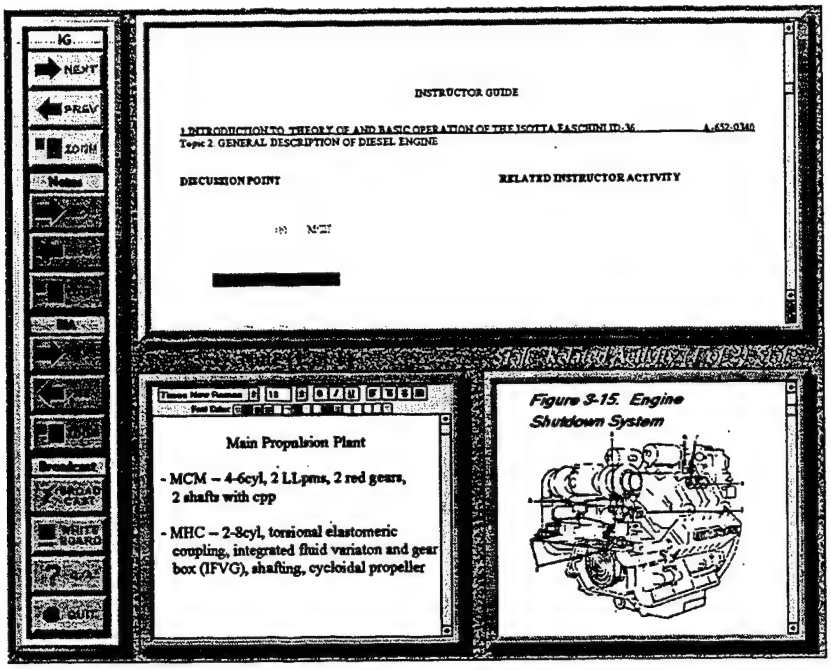

Figure 2. TIMS screen layout

The TIMS software components consist of commercial-off-the-shelf (COTS) MS-Windows compatible programs. The software components include:

Browsers. Browsers support the viewing of information located in curriculum databases. This information can be in many formats. For example, browsers allow instructors to display IGs created in Word Perfect or AIM. Instructors cannot edit the actual IG, but can add personalized notes known as annotations. Annotations can be linked to topics discussed in the IG for classroom presentation. A browser supports loading, adding, deleting, and saving annotations. The annotations may be text, animations, graphics, or multimedia. Instructors have the capability to page up and down within the IG, move from paragraph to paragraph, and zoom in and out. IG navigation features are accessible from a remote control unit as well as keyboard and mouse. A Word Perfect browser is presently in use and Guide and AIM browsers are being developed.

Instructor's Annotation Editor. This program allows instructors to directly enter text annotations and supports the editing of other media such as animations. When an annotated paragraph in the IG is selected, the linked annotations are displayed. These annotations can be directed to and displayed on student workstations or to a large screen such as an automated LiveBoard. Editor features are accessible from a remote control unit as well as keyboard and mouse.

Student's Annotation Viewer. This program allows the instructor's annotations to be viewed on student workstations. Instructors have control over what annotations are displayed.

Network Protocol. This software allows instructor and student workstations to exchange data.

File Sharing between Instructor/Student Workstations. This capability allows student workstations to share annotation data with the instructor's workstation. An example is a graphic file that the instructor can broadcast to the student workstation during lecture. File sharing allows a student to review the graphic or text while completing homework assignments. Another example is an animation file that could aid in understanding a difficult concept during after hours study.

Remote Control Unit for Instructor. An infared remote control unit allows instructors to navigate through the IG and its annotations from anywhere in the classroom. This is an advantage over the usual method where the instructor is required to remain close to the computer and podium as he lectures.

Instructor's Response Module. This program allows an instructor to activate a response pad on the individual student workstations for conducting classroom quizzes. Student responses are stored and displayed on the instructor workstation. The response pad accommodates True/False, Yes/No, and multiple choice responses. The responses are displayed on a desk-by-desk basis, and as a bar graph for the entire class. The response displays are color keyed for easy viewing by the instructor.

Student's Response Module. This program displays a response pad on the student workstation as directed by the instructor workstation. The response pad provides for the same responses as described above for the Instructor's response module.

User Interface. An effective graphic user interface has been implemented to ensure that information is presented clearly, the system is easy to use, and there is an artistic sense of layout and balance. Attention has been focused on functionality and placement of "buttons" or icons that represent links to annotations and navigation capabilities.

Student Performance

A comparison of student performance scores in the traditional paper-based classes and the IETM-based classes showed promising results as documented in the costs/benefits report (Mark, Kribs, Morris, & Dickason, 1996). The test scores for six paper-based GSE and GSM classes were obtained and used as a baseline. Test scores for seven GSE IETM-based classes and three GSM IETM-based classes were available for comparison at the time the report was prepared. There was slight improvement (Figures 3 & 4) in overall average student scores of 91.88 for GSE IETM-based versus 88.66 GSE paper-based and 92.23 for GSM IETM-based versus 90.60 for GSM paper-based courses.

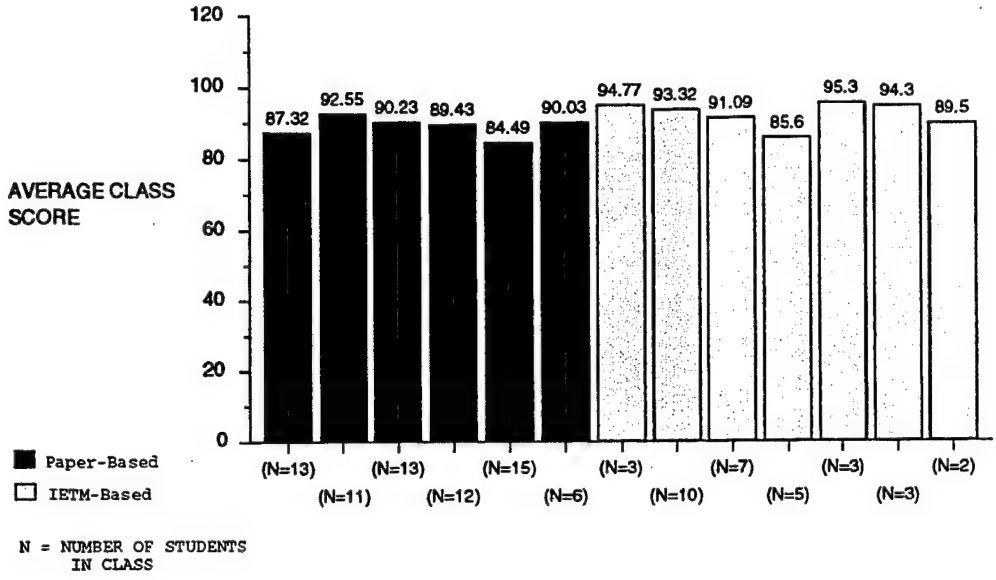

Figure 3. Test scores for GSE classes

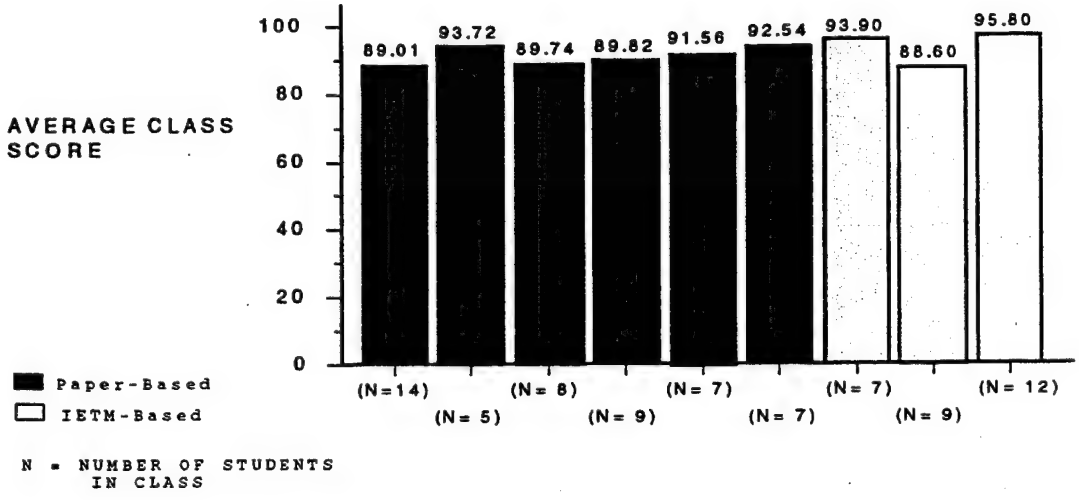

Figure 4. Test scores for GSM classes

Instructor Survey

Nine instructors completed a written survey of their experiences while teaching from the IETM/AC system. Half of the instructors had two or more years teaching experience. Overall, they ranged from less than one year to a maximum of 10 years teaching experience. Six instructors had previous, but limited, computer experience and none of them had taught with computers. The survey gathered demographic information, and experiences related to system functionality, classroom interaction, equipment used, subject matter, and facilities. A five point scale was used for the responses. S*trongly agree* had a value of five and *strongly disagree* had a value of one. The instructors' responses are shown in Figure 5 with the mean response value for each item displayed in the far right column.

Instructors reported the use of the computer made the course more interesting and supported the use of new media in the classroom, but were undecided or doubtful about how the system was affecting the flow of information. More software than hardware problems were reported. There were mixed feelings about the amount of class time lost due to program failures. In spite of some problems, instructors felt the computer should be used to enhance training and that the system will result in less time required to teach a course.

Only one instructor agreed with the statement, "I prefer the use of this system when compared to paper-materials". This seems surprising given a majority of instructors agreed that the computer should be used in other classes and the computer enhanced student learning. One explanation is that they felt this particular system did not meet their requirements for teaching even though they think that, in general, computers are a positive addition to the classroom.

At the end of the survey, instructors were given space to provide suggestions or comments about the system. Instructors felt information was easier to locate using the system. They liked the control the system gave them over what students saw on their workstations, the use of state-of-the-art equipment to display the training materials and drawings, and stated that the facilities provided a nice comfortable learning environment.

Instructors were concerned about the students entering their notes on the computer during class. Students lacked typing skills, which made note taking on the computer time-consuming and distracting during lecture. Instructors suggested improvements could be made to the LiveBoard resolution and pens. The graphics were reported to be of poor quality, probably because they were scanned from technical manuals rather than re-authored using graphics software.

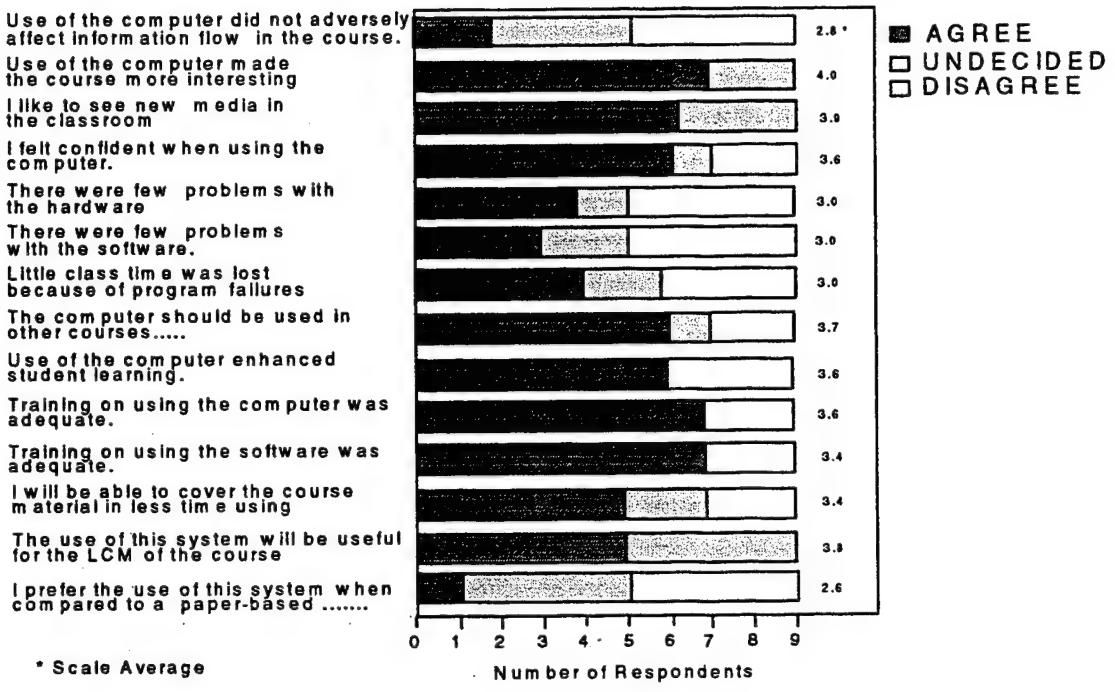

Figure 5. Instructor survey results

Structured Interviews

Structured interviews were conducted with supervisors, managers, and support personnel. Instructors were interviewed in pairs from both the GSE and GSM content areas.

Instructors

A total of eight instructors were interviewed, six GSE and two GSM instructors. In general instructors thought the automated classroom and the IETM had a lot of potential for improving the current courses of instruction. However, they were greatly concerned about the "final product" (the trainees being sent to the Fleet) in the current implementation. These concerns centered around three main areas: (1) The IETM, (2) the reduction in course length, and (3) the need to better understand how to teach in the new electronic environment. The concerns about the IETM centered around the poor quality of the IETM graphics. This was especially evident with the GSE instructors who had to use the wiring schematics for instruction. A majority of instructors voiced concerns about the reduction in course length. One of eight instructors was concerned about the revisions made to the courses. Several instructors stated that they felt the graduates of the automated classrooms were not as well trained as previous graduates. They thought the increase in performance scores that the IETM classes had shown were due to easier, multiple choice tests and smaller class sizes. The third area of concern was their need to

understand how to teach in the new classrooms. While the majority felt comfortable with the mechanics of using the new technology they were less comfortable with the most effective way to use the technology to "get the point across."

Supervisory personnel

Two of the supervisory personnel responsible for the GSE and GSM areas were interviewed. Their primary concern was centered on the amount of effort required to get the automated classrooms up and running and to keep them running. Since computer technology is evolving so quickly there is a felt need to plan for equipment upgrades on an almost continual basis. Related to that is the need for additional billets to support the automated classrooms. Currently, personnel who have some computer expertise are assigned computer support tasks. They have no special training and are basically learning on the job. This assignment may be in addition to their regular duties in the schoolhouse.

Support personnel

Three personnel who man the IETM support office were interviewed. They have responsibilities that have accumulated over time. Their concerns were centered on the need for additional billets for classroom support as well as the need to provide additional levels of security for the existing computer systems. They would like to see a system that allows instructors and trainees access to only that part of the system they need to fulfill their responsibilities.

Overall the personnel interviewed seemed to have positive comments about the automated classrooms. Major concerns were the need for more experienced computer support personnel, the perceived lack of quality graphics in the Gas Turbine IETM, and a concern over the reduction in the length of the training courses.

Student Survey

Forty-eight students, 26 GSE and 22 GSM, completed the survey. We found that 60% of the students had previous computer experience, mostly two years or less, but few had used computers in a classroom setting. Keyboarding or typing skills varied greatly, with most in the hunt-peck or novice categories.

Figure 6 summarizes the responses made in the survey. The survey gathered demographic information, and experiences related to system functionality, classroom interaction, equipment used, subject matter, and facilities. A five point scale was used for coding responses, with *strongly agree* having a value of five and *strongly disagree* having a value of one. The mean response value for each statement is displayed in the far right column of Figure 6.

Students expressed a mixed reaction to the computer and how smoothly the information flowed during lectures. They liked the capability to access the IETM quickly during tests, supported the use of new media in the classroom and thought the computers made the course more interesting. Most of the students felt the instructor was confident using the system. As for

hardware and software problems, opinions were varied. Students knew this was a new system, were aware of equipment failures, and recognized that the software needed refinement.

The next section of the survey asked students to respond to open-ended questions. When asked for suggestions to improve use of this technology in the classroom, students were mostly concerned with improving the graphics. Other suggestions included completing the program (some hyperlinks were not linked to text or graphics in the prototype), improving monitor resolution, and improving the system performance. Four students reported there was a need to use paper schematics and diagrams. Seven students wanted to see keyboarding and computer training offered before the course.

The last section of the survey provided space for students to provide suggestions or comments about the classroom system. They were given these topics to consider: classroom interaction, instructional strategies, equipment used, subject matter/curriculum, and facilities. Students liked using the computer and having the information displayed on the large LiveBoard™ in the front of the classroom. Most comments focused on the state-of-the-art system, which provided easy access to information and diagrams. Students liked the animated drawings and found the training materials useful and easy to reference. They found it more difficult to trace signals on the LiveBoard and suggested paper might be more suitable for this application.

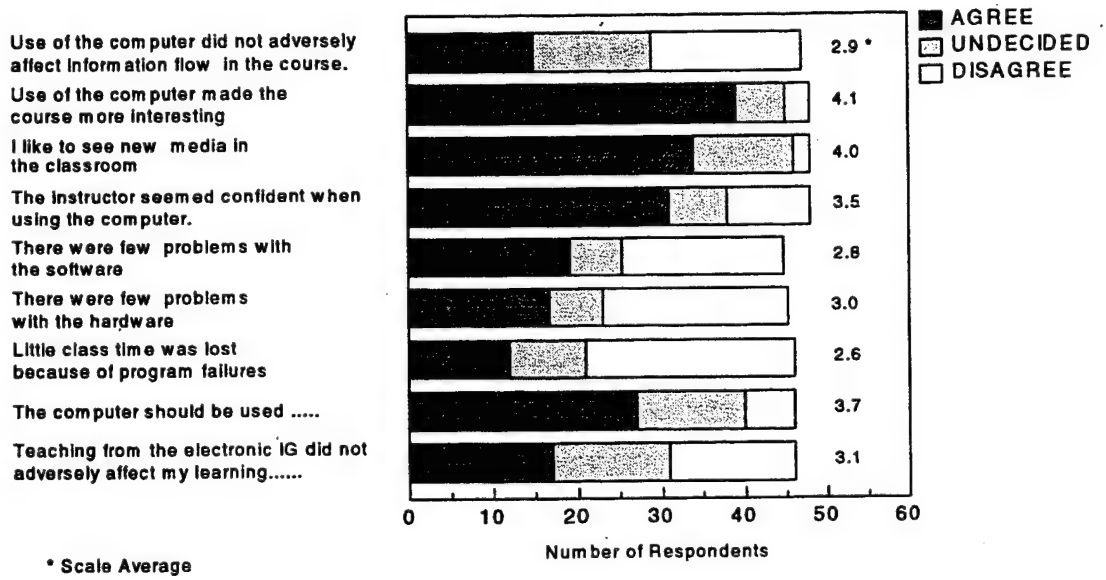

Figure 6. Student survey results

Institutional Impacts

Interviews with school administrators and instructors revealed many institutional impacts as a result of implementing the IETM/AC system. The first few Gas Turbine instructors received two weeks of IETM/AC system training from the contractor. These instructors in turn trained other instructors to use the system. This put additional time constraints on their already busy schedules. Corporate knowledge of this type is very perishable and places a burden on the school as the military instructors transfer to other duty stations.

As stated in a lessons learned document (Fretz, 1995), the necessity for quickly developing the IETM/AC system led to some software selections that proved inadequate. Windows for Workgroups provided a quick and simple networking capability at the time, but it lacks the more robust network administration and security features needed for long term use in the schoolhouse. The contractor combined the IG/TG with the IETM, which later proved to be problematic. When a course or IETM has been revised, the contractor must make the changes and produce a new CD-ROM. The course should not be sent to the fleet as part of the IETM CD-ROM. The training organization loses control over the instructional materials meant for classroom training.

Along with the IETM/AC system comes a requirement for additional support staff for system administration, maintenance, security, and life cycle maintenance of the courses. Billets have not been established to meet these demands. The existing staff has taken on these responsibilities as collateral duties, but this is not a long term solution. Personnel have been assigned to these tasks with a minimum of training and experience. As for course development and maintenance, responsibilities need to be defined for the curriculum developers and instructors. For example, when a course or IETM changes someone must establish software links between the IG and the IETM and provide the instructor with the latest version.

The size of the classrooms limited the throughput by lowering the class size from a maximum of 25 students to 12 or 15. Instructors and students had to adapt to this change in their classroom environment. Instructors are learning new presentation techniques and becoming innovative as they learn new methods for annotating their IGs. On the student side, there are no instructional materials to study from after hours. Computers are not available in the barracks. Therefore, students must return to the classroom to study and complete assignments. This requires a better long term solution, perhaps integrating the classrooms with the Learning Resource Center.

Conclusions

Early efforts to develop automated classrooms were problematic due to immature software for developing and displaying graphics and text information (Kribs, 1994). Because of increasing instructional development and maintenance costs, making use of advancing computer technologies offers the most efficient alternative. In the past, there was considerable time and cost associated with developing automated systems for classroom training. Initially, computers powerful enough for these applications were much more expensive and there were few programs available that supported development of materials that were SGML compatible. There were

many risks associated with system development, the need for custom software, course development, and networking hardware and software.

Advances in technology based on electronic data conversion, storage, transfer and standards have provided the basis for developing prototype instructor and student workstations that may provide significant advances in instructional development and presentation effectiveness, and efficiencies in costs (Kribs, Mark, Morris, & Dickason, 1996; Mark, Kribs, Morris, & Dickason, 1996). It is now possible to include: (a) high quality digital multimedia, (b) hypertext/hypermedia, (c) the capability to store digital media materials more efficiently, and (d) transmission of multimedia through local, wide area, and worldwide networks. There are, however, very few instances of this technology being fully integrated into a Navy training environment.

An important aspect of the current IETM/AC system is the use of COTS hardware and software, and that the classroom is not dependent on any one feature or vendor. As new computer and instructional technology become available the development and presentation packages can be utilized in the existing classroom.

The IETM/AC expanded system architecture, using TIMS, accepts course materials from a variety of sources including AIM, SGML editors, instructional authoring programs, and PC word processors. Augmenting TIMS will provide several benefits beyond the classroom. Cost savings should be achieved by eliminating the requirement to convert legacy data and course materials prepared with word processing or other authoring programs to SGML format. Typical costs for translating materials from standard word processing formats to SGML are several dollars a page, and millions of pages of such materials are presently used in Navy classrooms.

The prototype IETM/AC contains instructor and student workstations that support instructor-student interactions, presentation of the curriculum, student practice and testing, and monitoring of student responses. These functions are accomplished with automated IGs which guide instructor activities, local area networks for interconnecting students and instructors, student response monitoring, and instructor controlled multimedia presentations.

The IETM/AC has tremendous potential to become tomorrow's tradition by providing a new innovative learning environment. Instructors and students learned to use the IETM/AC system in a short amount of time. With the point and click Windows interface, rapid information retrieval is possible. Students quickly became familiar with the functionality of the system. In just a few days, students became comfortable using the computer for learning. In the future, as students and instructors have more computer experience, this transition will become easier. Instructors will become more innovative as they realize the potential of the IETM/AC.

Reduction in training time and course length have resulted in cost savings. Additional savings are projected due to reduced time and effort for course maintenance and reproduction of materials (Mark, Kribs, Morris, & Dickason, 1996). As should be done before any course is automated, the GSE and GSM courses were revised. The resultant efficiencies are due to a thorough course review, rapid retrieval of information in the classroom, and less instructor lecture preparation time.

Recommendations

Choose the appropriate course for automation. The course targeted for automation should undergo a thorough Instructional Systems Design analysis before the training materials are developed.

Conduct a site survey to include required facilities modifications, course and personnel requirements, and visit an established automated classroom to learn from other's experiences.

Keep IGs and TGs separate from the IETM. Course materials should not be embedded in the IETM. This will save money and time when either the course or the IETM requires revision; there will be no need to return to the IETM source for curriculum revisions.

Billets should be established for systems administration and life cycle maintenance of hardware, software, and courses. Existing instructors and support personnel cannot provide the necessary support without additional training and billets. The number of billets is dependent on the complexity of the automated classroom. Using a single, stand-alone instructor station may not require any additional billets.

Learning Resource Centers should be integrated with the classrooms, be staffed by instructors and be available for after hours study. This will free up classroom space for other courses and provide needed student access for after hours studying.

Multiple classrooms should be networked with a central file server. This will allow sharing of data, easy reconfiguration of classrooms with different courses, and make course maintenance more efficient. Life cycle maintenance and configuration management are more difficult if classrooms are not networked.

Instructor workstations should be available in the instructor preparation areas. This will allow them to personalize their materials and prepare for lectures without tying up the classroom. These workstations should include such peripheral equipment as will allow instructors to take advantage of the new multimedia environment.

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